Space Weather Technical Forecast

Issued on Wednesday 8 January 2025 at 00:45 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of isolated M-class flares. Active electron fluence expected day 1 (08 Jan).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with one long-duration M1.1 flare observed peaking at 07/2305 UTC, likely from AR3941 from just over the southwest limb. There are nine regions currently visible on the Earth-facing disc, with only one notable region AR3947, now approaching the north-centre disc. This has simplified a little compared to its recently very active phase, but remains moderately sized with some mixed magnetic polarity spots through its intermediate region. The other regions across the disc are all much smaller and simpler, and either stable or showing signs of decay.

No Earth-directed CMEs were observed, with those visible in current imagery off the Earth-Sun line.

Solar Wind / Geomagnetic Activity: Ongoing fast wind from CH05/+ gradually eased after a weak and glancing CME arrival evident between 07/0430-1250 UTC, likely due to the passing of the shockwave of the eruption from AR3939 on 04 Jan. Solar wind speeds were initially elevated at 500-550km/s and eased to near 470km/s by the end of the period, but with a period of 550-600km/s 07/0430-1250 UTC due to the passage of the CME. Interplanetary Magnetic Field, Bt, was Weak, but very briefly reached Moderate after the CME arrival peaking at 8nT. The north-south component, Bz, was variable between +/-7nT, but slightly favoured a southward direction after from 07/1250 UTC. Phi angle was mostly positive (away from the Sun), but more variable during the CME passage. Geomagnetic activity was Quiet to Unsettled (Kp 2-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES-18 was near background. High energy electron flux (greater than 2MeV) at GOES16 was initially Moderate, but rose to be High between 1135-2325 UTC, peaking at 3070 pfu at 07/1850 UTC. The associated 24 hour fluence rose in response, to be just under the Active threshold by 08/0000 UTC, reaching 8.87e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate is expected with an ongoing chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CME's. Current fast winds from CH05/+ are expected to continue erratically easing through day 1-2 (08-09 Jan) towards

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background to slightly elevated levels, before a further brief enhancement is likely from CH07/+ fast winds on days 3-4 (10-11 Jan). Geomagnetic activity is expected to be mostly Quiet with isolated Unsettled intervals. There is a chance of this increasing to Unsettled to Active with a slight chance of G1/Minor Storm intervals with the fast wind onset.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is near background. GOES 16 high energy electron flux is forecast to continue at Moderate to High, perhaps becoming mainly High with the associated 24 hour fluence expected to rise above the Active level on day 1 (08 Jan). This is likely to persist at this level, but with a decreasing confidence, especially from day 3 (10 Jan) onward with any further fast wind onset.

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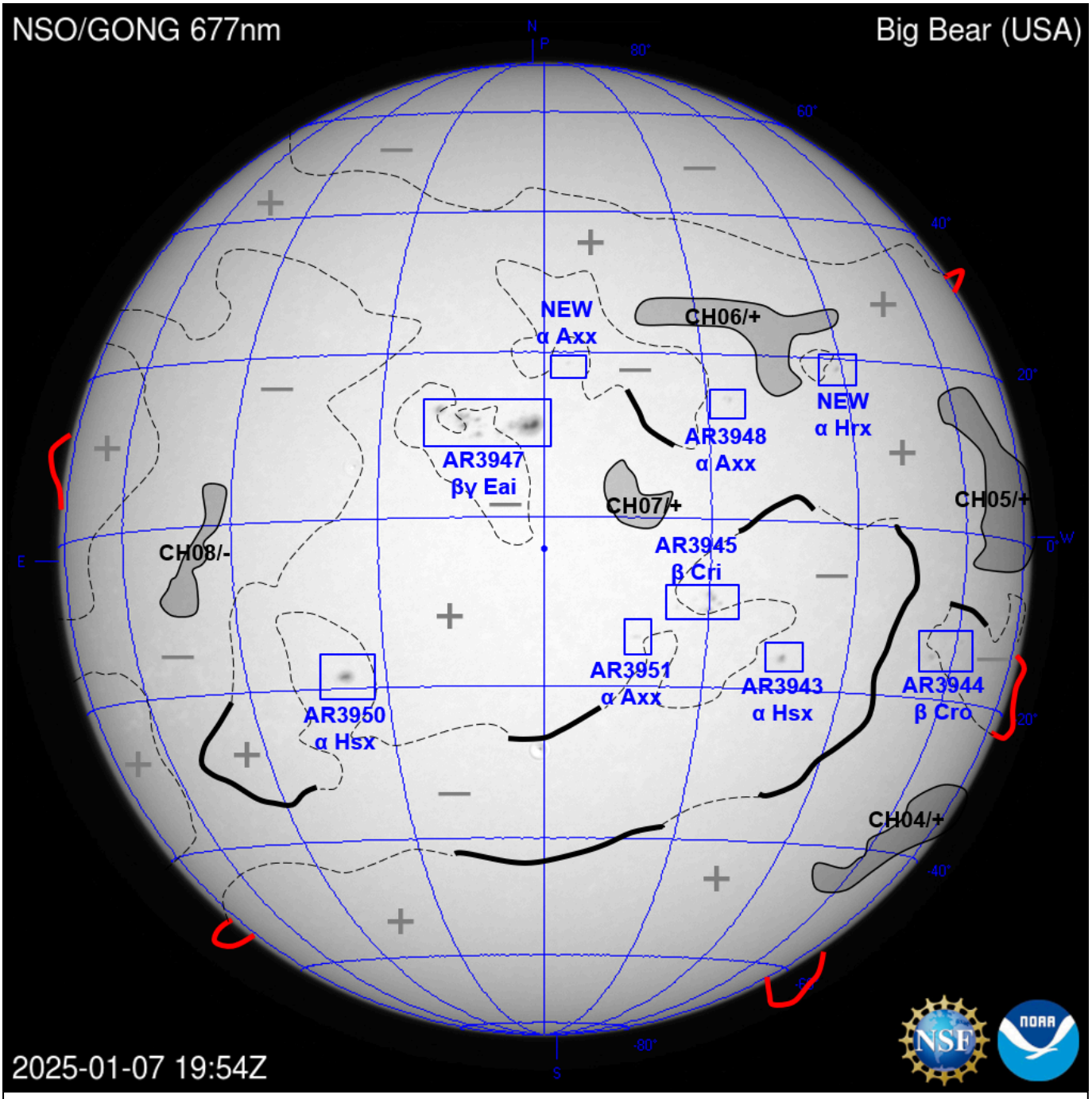
Figure 1: MOSWOC Solar Synoptic Map 07/2000 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are no Earth-directed CMEs. The M4.8 flare at 06/1624 UTCV from AR3947 produced an associated Type II radio emission, however no CME has been observed in coronagraph imagery. While uncertain, the Type II may have been a result of the observed EUV wave in the Sun's corona, which is observed in e.g. GOES SUVI 195 imagery, rather than the successful generation of a CME. Any material released is now considered too minimal to have an influence on this forecast.

Solar winds are currently easing after being connected to the fast wind of CH05/+, and this erratic decline in wind speeds is expected to continue through day 1-2 (08-09 Jan) as solar winds ease. There are a number of other small coronal holes on the disc, however the only feature that is likely to influence Earth is CH07/+. This is a small feature, with its weak fast wind likely to move through on day 3-4 (10-11 Jan), perhaps bringing a brief increase to solar winds, to around 450km/s. This is similar to the previous rotation, as while the coronal hole is smaller on this occasion, this does not always correspond to the observed speed of the fast wind at Earth. CH06/+ in the northwest is likely too far north to have an influence on the Earth.

Geomagnetic activity is expected to be mostly Quiet with isolated Unsettled intervals. There is a chance of this increasing to Unsettled to Active with a slight chance of G1/Minor Storm intervals with CH07/+ onset day 3-4 (10-11 Jan).

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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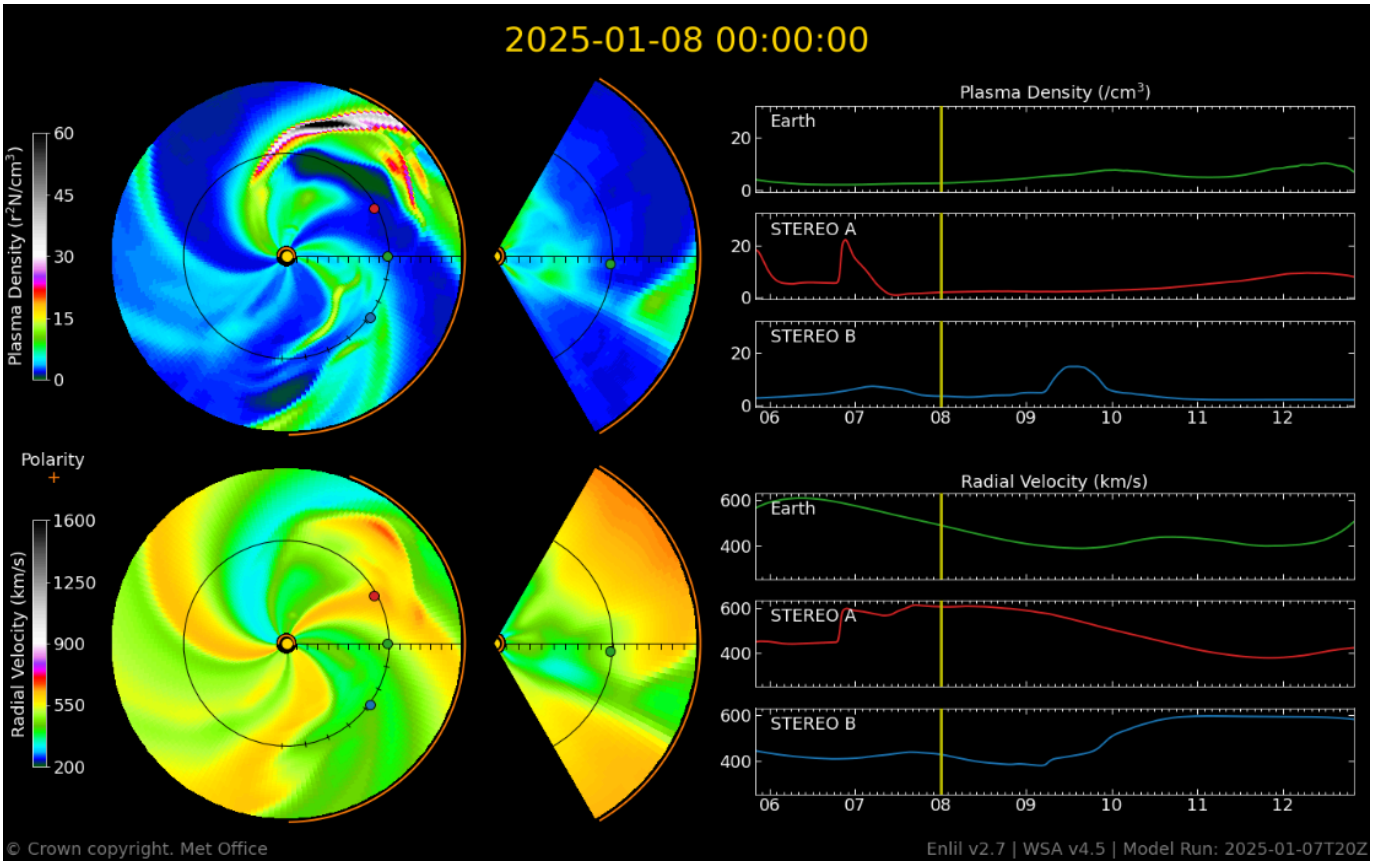
Figure 2: MOSWOC Enlil. Easing fast wind shown, along with very slight enhancement from CH07 on 10-11 Jan



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Radio Blackouts - X-Ray Flares

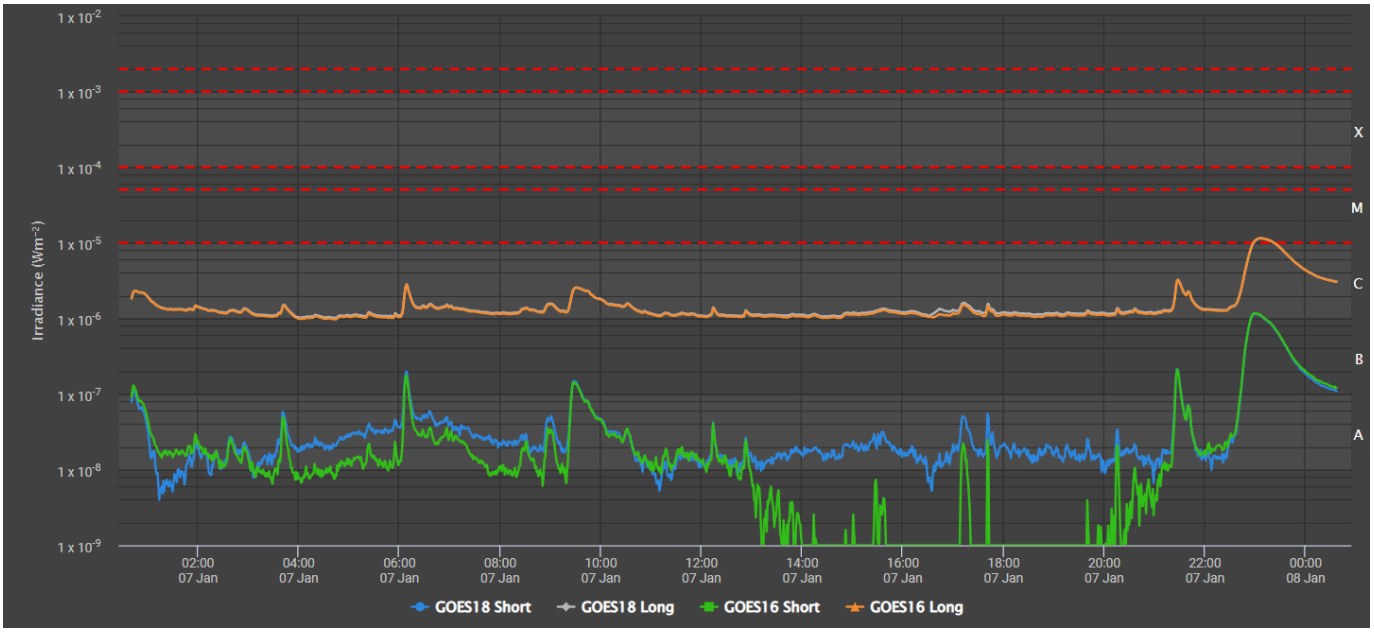
Low to Moderate activity is expected with a chance of isolated M-class flares possible, mainly from AR3947 which is the only notable sunspot group of the nine currently on the Earth-facing disc.

AR3947 has been the source of much of the recent activity, including the X-class flares on the previous days, however in the last 24 hours this has simplified somewhat alongside the Sun's activity subsequently easing. However the region remains moderately sized, and its magnetic structure remains weakly mixed with the polarities through the intermediate spots. and there is a suggestion of a very weak delta-spot, although this has been difficult to confidently identify due to its weak appearance.

Across the rest of the disc, the other eight regions are all very small and simple, and either stable or showing some sign of decay. This incudes AR3945 in the southeast, which was the source a C-class flare (C3.2) in the last 24 hours.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	60	60	60	60
Very Active	R3-R5 (X Class)	No	10	10	10	10

Figure 3: GOES-16/18 X-ray Irradiance showing limited activity aside from the M1.1 from over SW limb.



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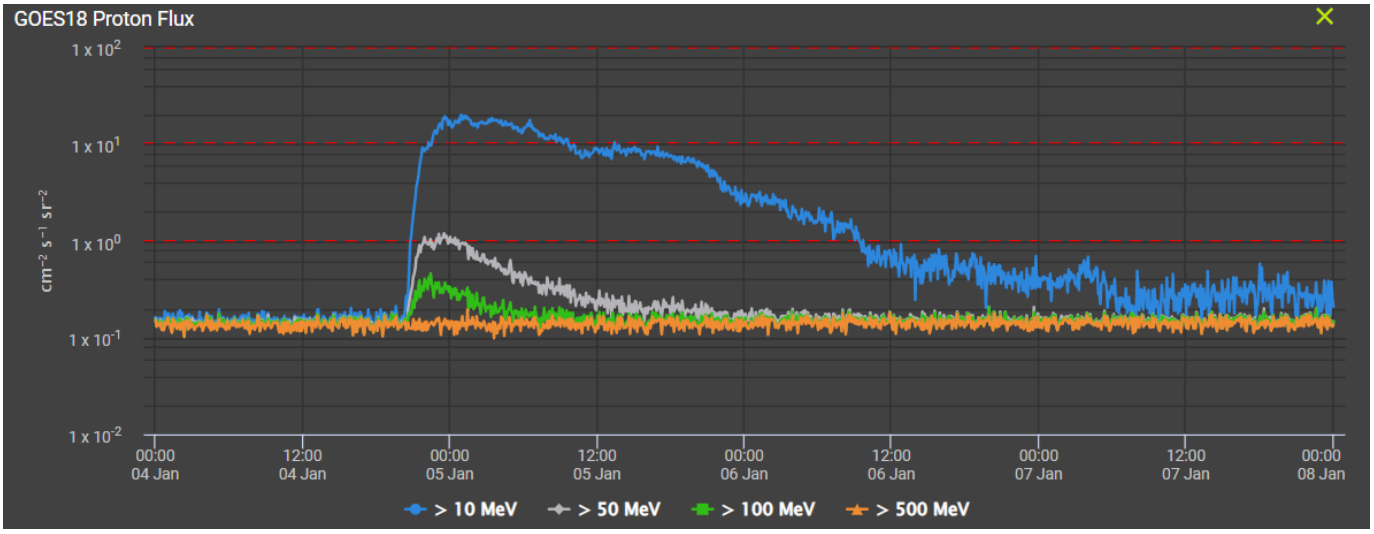
Solar Radiation Storms (High Energy Protons)

GOES18 high energy proton flux is now near background, having eased after the recent enhancement. The source of this enhancement AR3939 is now onto the far-side, with a decreasing potential to erupt high energy protons that can be observed at Earth. However a slight chance of further enhancement is maintained due AR3947 which is now approaching the centre disc. While less active than recently, this will continue to provide a chance of further flares as this moves into the western hemisphere, which is better connected for observable high energy protons at Earth. Furthermore, there are a number of filaments currently on the western disc, and it is not impossible that a large eruption from any of these could result in Earth-directed high energy protons.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES-18 Proton Flux since 04 Jan for a number of energy levels



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High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 climbed from Moderate to mainly High values. This is as a result of solar winds now gradually easing, after the combined effect of the fast wind enhancement from CH05 and recent weak glancing CMEs. This sequence of events would have led to the charging of the Van Allen Belts, albeit at lower orbital levels, and then as solar winds ease, the radiation belts have then expanded back to incorporate GEO. Subsequently the observed flux has risen, and is likely to remain high for much of the period. The main suppression is likely to come from any weak influence of the fast wind from CH07, most likely on day 3 (10 Jan).

Fluence is currently near the Active threshold, and with a rising trend. This is expected to soon rise above the Active threshold on day 1, with a decreasing confidence of then persisting above, especially day 3 (10 Jan) onward due to any potential fast wind onset. This rising trend is supported by REFM, however this is currently slightly underestimating expected values.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	80	70	50	30
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

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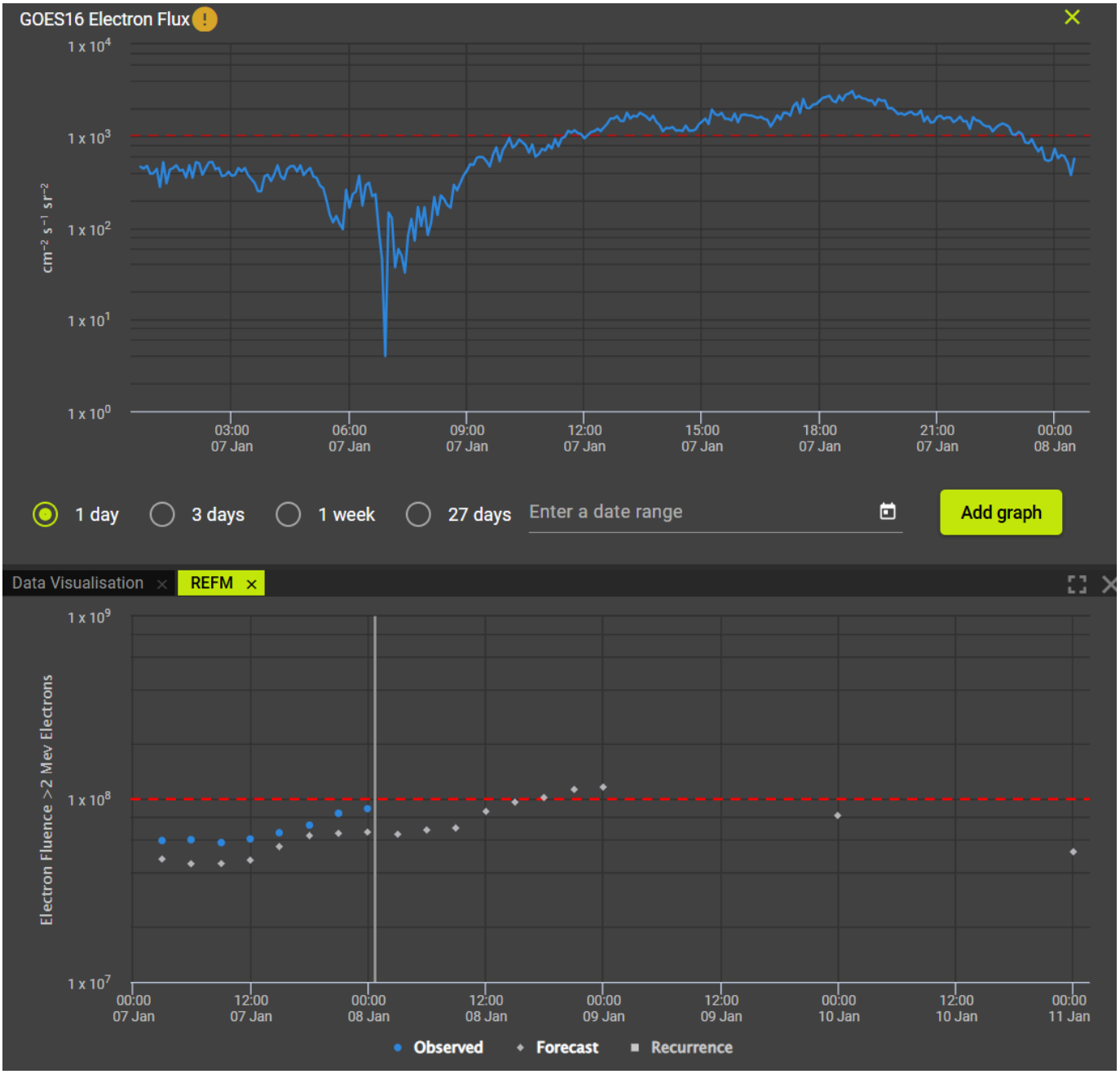
Figure 5: GOES-16 Electron Flux (top) and associated 24 hr fluence with REFM (bottom)



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